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THE LITERATURE OF SCIENTIFIC MANAGEMENT

SUMMARY

Introduction, 506. — 1. Development and Theory of Scientific Management, 509. — Earlier discussion, 510. — The successive publications of F. W. Taylor, 511 ; — of Gantt, 514. — Essentials of Taylor's system, 518. — Various other publications, 521. — Emerson's books, 527. — 2. Scientific Management in Operation, 530. — 3. The Railroads, 533. — 4. Methods; general articles and books, 538. — Time study, 540. — Motion study, 541. — Other questions, 543. — 5. The Personal Factor, 547. — Bearing on larger social problems, 551. — 6. Relation to Organized Labor, 553.

Any discussion of the literature of scientific management is confronted at the outset with the question, What is scientific management ? The development of the factory system brought with it many new problems connected with the organization and management of labor, the structure and equipment of factories, and the technique of production. By successful manufacturers these problems have always been solved in a way to make manufacturing at a profit possible. Early solutions, however, were necessarily crude and roughshod. With the enormous increase in demand for manufactured products, in the investment of capital, and in the number of men engaged in the business, with the consequent development of ever-keener competition, the early methods have been found insufficient. Especially within the last twenty years a degree of skill and technical training has been brought to bear upon the solution of factory problems which has made modern factory management a thing much more elaborate, refined, and effective than ever before. A series of improvements in administration and methods have been made by many engineers and managers, and not a few of them have been developed by a method which might truly be called scientific. Where, then, can we draw the line between modern management in general and what has come to be known technically as " scientific management " ?

Out of the mass of engineers and managers who are responsible for present-day methods, there has grown a group originating with Mr. Frederick W. Taylor of Philadelphia, who have perceived certain principles underlying the practices of management hitherto unrelated and uncoördinated. A collation of isolated successful experiments in various details of factory administration and methods has apparently shown a possibility of classification and generalization. Such classification and generalization are the basis for the development of a science, and the term " scientific management " is applied generally to the body of principles deduced from experience by Mr. Taylor, and the engineers associated with and trained by him, and to the methods by which the resultant principles are applied to industry. " Scientific management," therefore, is distinctively scientific, since it aims to correlate and systematize all the best of modern developments in factory administration, and to push development further in accordance with the principles discovered.[1]

On the basis of this definition it is not difficult to select that portion of the large current literature of factory management which deals with scientific management from that other portion which describes and outlines the many unrelated improvements, methods, and principles which are continually being evolved. The literature of scientific management as such is that which has been published by those who approach the subject in a scientific manner. Of these Mr. Taylor is the acknowledged pioneer and leader both in practice and theory.[1]

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[1] Mr. Charles B. Going has published an article, " The Efficiency Movement — an Outline," Transactions, The Efficiency Society, vol. 1, p. 11, showing the place of scientific management in the modern developments of factory organization and pointing out the common element in many movements.

The literature of scientific management is found in a few books written by practitioners of the science, a few official reports growing out of disputes as to railroad rates and labor difficulties, technical articles which have appeared in the transactions of engineering societies and in engineering and other technical magazines, and a considerable mass of "popular" articles written to satisfy the recent widespread popular interest in the subject.

These books and articles may be classified, for the purposes of the present review, in six groups.

The first group includes those incidental to or dealing with the development and theory of scientific management as a whole. It consists of the original publications of the pioneers and such popular statements as reveal a clear grasp of the movement.[2]

The second group includes descriptions of scientific management in operation, written as a rule by managers of plants which have developed the system.

As a result of the injection of scientific management into the discussion of railroad rates, there has arisen a considerable body of literature on the possibility of the application of the system to railroads. This is of sufficient consequence to constitute the third class.

In the fourth class are the many detailed descriptions of methods which are either distinctive of scientific management, or, tho not peculiar to scientific management, coördinated and assimilated by it into its own system.

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[1] With the possible sporadic exception of Charles Babbage, whose book, The Economy of Manufactures, was published in 1832, fifty years ahead of its time.

[2] Many of the popular articles are evident pot-boilers, too ill-considered and ephemeral to be worthy of discussion and preservation.

Those methods of scientific management which affect most directly the human factor in production have stimulated a literature which is of sufficient importance to warrant being put into a fifth class by itself.

In the sixth and last group is the series of discussions dealing with the relation of scientific management to organized labor.

The more important books and articles are discussed briefly in the text. Others not sufficiently distinctive or noteworthy to call for special review, but important for students of the movement, are referred to in the notes. The text and notes together cover nearly ninety per cent of all that has been published on the subject in English.

1. Development and Theory of Scientific Management as a Whole

In 1832, Charles Babbage, the eminent mathematician, published a book [1] in which he attempted to deduce from the practice of manufacturing as it existed in his time, the general underlying principles which apparently controlled it. This piece of work, tho crude in the light of modern advance, was so far ahead of the state of contemporary manufacturing intelligence that its significance was entirely overlooked, and it is only today that the force of his analysis is evident. Altho it does not appear that the modern group of scientific managers are in the slightest degree indebted to Babbage's work, it is interesting to observe in it the suggestion of the extension of specialization beyond manual labor to mental labor, which is at the basis of the Taylor doctrines of functional foremanship and the separation of planning from execution. Babbage also foreshadows the use of timing as an aid in the development of processes; but in this he was not so fortunate, and the undeveloped method he used is not even remotely connected with modern time study.

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[1] The Economy of Manufactures. London, 1832. (Out of print.)

The important stimulus to the modern development is found in the work of a group of managers and engineers, members of the American Society of Mechanical Engineers, who drew the attention of their fellow-members to the influence of wages on the output of workmen. The earliest of these was Mr. Henry R. Towne, president of the Yale & Towne Manufacturing Company. Mr. Towne has always been essentially a thinker in industry. Early in the '80s he wrote a paper[1] which was a plea for the technically trained engineer to concern himself in the financial and profit making aspects of management — to be an "economist" because he effects economies. As a result of taking his own advice in his own plant, and after a realization of the practical inefficiency of profit sharing as an incentive to production, Mr. Towne evolved[2] and described a modified type of profit sharing which he called "Gain Sharing." It consisted in modifying profit sharing by applying it to departments instead of to the business as a whole, and basing it upon demonstrable gains in the efficiency of departments as evidenced by careful accounting. Out of the discussion of this paper grew practically the entire modern literature on wage systems as incentives.

Prominent on this subject were the papers of Mr.

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[1] "The Engineer as Economist," Transactions, American Society of Mechanical Engineers, vol. 7, p. 425. These transactions will be abbreviated hereafter Trans. A. S. M. E.

[2] "Gain Sharing," Trans. A. S. M. E., vol. 10, p. 600.

F. A. Halsey and Mr. James Rowan[1] and an article by Mr. Rowan.[2] The object in the mind of these managers was to provide a definite basis on which gains in efficiency could be measured, and to bring the gain and the consequent bonus home to the individual workman. It was an attempt to remedy the defects both of profit sharing with its indefiniteness and of piece rates with their temptation to cutting; and it amounts practically to the rough determination of a standard of individual performance and the announcement in advance of a systematically graded and expected cut.

While this discussion (the very considerable literature of which is outside the scope of this paper) was in progress, Mr. Frederick W. Taylor, an engineer of Philadelphia, who had become foreman and master-mechanic of the Midvale Steel Company, was trying to solve the problem of individual and plant efficiency by another and an essentially different method. One result of his experiments was the development of a new form of piece rate now known as the "differential piece rate," according to which a workman is paid a low rate per piece for ordinary production and a considerably higher rate for production according to a standard, determined by careful and accurate time study, and made possible of attainment by systematic training of the workman and by such management of the plant as facilitates to the utmost the operations performed by the laborer. Mr. Taylor's first statement of his methods and results was submitted to the American Society of Mechanical Engineers in a paper[3] which has been described by Mr. Going, the accomplished editor of the *Engineering Magazine*, as " one of the most valuable contributions that have ever been made to technical literature."

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[1] "The Premium Plan of Paying for Labor," Trans. A. S. M. E., vol. 12, p. 755. Reprinted in Sibley Journal of Engineering, vol. 16, p. 219, and in "Trade Unionism and Labor Problems," chap. xi, edited by John R. Commons. Boston, 1905.

[2] "A Premium System Applied to Engineering Workshops." Proceedings, Institute of Mechanical Engineers, March 20, 1903, p. 203.

[3] "A Piece Rate System," Trans. A. S. M. E., vol. 16, p. 856.

At this stage of the development, the system consisted of " three principal elements: (1) an elementary rate fixing department, (2) differential rate system of piece work, (3) what he (Mr. Taylor) believes to be the best method of managing men who work by the day." The rate fixing department analyzes and standardizes work and piece rates with the aid of elementary time study. This procedure differs from that of other rate fixing departments " in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed and when a piece work price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data."

The differential rate system of piece work is defined briefly as " offering two different rates for the same job, a higher price per piece in case the work is finished in the shortest possible time and in perfect condition, and a low price if it takes a longer time to do the job, or if there are any imperfections in the work (the high rate should be such that the workman can earn more per day than is usually paid in similar establishments)." The best method of managing men who work by the day " consists of paying *men* and not *positions*. Each man's wages as far as possible are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition." The advantages of this system as deduced by Mr. Taylor from ten years' experience with the Midvale Steel Company are: first, lower cost of production with, at the same time, higher wages; second, by substituting knowledge for guess work, the elimination of the motive for "soldiering"; third, the substitution of exact knowledge leads to a treatment of the men with greater uniformity and justice, and their response with more and better work; fourth, coöperation of the men and the management is made obviously their common interest; fifth, the system is rapid in attaining the maximum productivity, which is automatically maintained by the differential rate; sixth, it selects and attracts the best men, develops many slow and inaccurate workmen into first class men, and discourages and sifts out men who are incurably lazy or inferior; seventh, "it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary."

The paper then proceeds to discuss the Towne and Halsey wage systems and profit sharing, and points out the absence in all of them of a definite measure of a day's work. It then describes the method of elementary rate fixing and the application of the differential piece rate by its means, with illustrations of the results attained.

It is significant of Mr. Taylor's habit of mind that this early paper is a description of methods and results, including hardly a suspicion of theoretical deduction. It is a testimony to the accuracy of Mr. Taylor's later statement that scientific management is not a theory to be applied to practice, but that it is first and primarily a practice out of which, many years after its beginning, a theory has developed.[1]

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[1] An interesting description of the application of this form of piece rate is found in "The Taylor Differential Piece Rate System," The Engineering Magazine, vol. 20, p.

The difficulty of bringing a plant to the necessary perfected degree of administration and the apparent severity of the differential piece rate led one of Mr. Taylor's collaborators, Mr. H. L. Gantt, to develop a different form of premium system, which retained, however, the essential element of an accurate time study basis. This method, known as the "Gantt bonus plan," is a time rate method. It guarantees the operator the regular hourly or daily rate but adds a bonus for achievement of the standard quantity and quality of work, known as "the task." This standard is set, as with Mr. Taylor's differential piece rate, by time study. Mr. Gantt has published a large number of articles on the subject, the best of which, together with his own development of the relation of scientific management to some of the human problems involved, have been collected in one volume.[1]

Mr. Gantt points out how by the ordinary methods of management the cost of production, which is at the basis of the great problem of the increasing cost of living, follows a vicious circle of higher wages to meet higher cost and increased cost as the result of higher wages. The way out is to manage production in such a way that higher wages bring a decreased cost; and this is the aim of scientific management. This is accomplished by standardizing the conditions for efficient operation, instructing the workmen thoroly in the best methods, and using wages as an inducement to them to accept the instruction and the conditions provided. The development of the Gantt bonus and its relation

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617, by Mr. Sanford E. Thompson, one of the early collaborators with Mr. Taylor and a recognized expert on time study. A good discussion of the whole matter grew out of a weak paper by Mr. F. Richards, "Is Anything the Matter with Piece Work?" Trans. A. S. M. E., vol. 25, p. 68, participated in by Mr. Taylor, Mr. Emerson, and others.

[1] Work, Wages and Profits. New York, 1910. The first edition, published in 1910, is somewhat enlarged and considerably revised in the second edition, 1913.

to piece work are described in detail, and the effect of the system on the workman's habits of industry and coöperation is outlined and demonstrated with charts and diagrams showing comparisons between old methods and the new. These charts, based upon the records of actual workers, are extraordinarily interesting human documents, showing the gradual overcoming of difficulties and the fixation of habits of punctuality, reliability, and efficiency. The 1913 edition adds a chapter to the effect that, as the great natural resources of this country can be relied on less and less in competition with other countries, our future depends upon the application of scientific methods and the increase in the efficiency of operation, and concludes with a brief chapter illustrating some of the detailed methods of the Taylor System as developed by Mr. Gantt.

This book of Mr. Gantt's is one of the best that has appeared on the subject and is entitled to rank with Mr. Taylor's *Shop Management* and *The Principles of Scientific Management*, as one of the standard authorities.

Scientific management, however, is not merely a system of wage payment. One of its essential features is the determination and application of standards not only of performance, but of methods and equipment. In fact, it is a cardinal principle of scientific management that a proper standard of performance cannot be attained in the absence of standardized methods and equipment; and it was in the effort to secure standard performance that Mr. Taylor and his associates were led to investigations of detailed processes which have themselves become classics. One of the earliest of these is Mr. Taylor's "Notes on Belting,"[1] which, with the later paper by Mr. Carl G. Barth,[2] has had an immense influence on the current manufacture and use of belts. Another investigation growing out of Mr. Taylor's work was concerned with the proper composition and method of heat treatment of tool steel, and the shape of cutting tools. This investigation, carried on with the assistance of Messrs. Gantt, Barth, and Maunsel White, and extending over twenty-six years, led incidentally to the discovery of high-speed steel, which has revolutionized machine shop practice and the design and construction of machine tools all over the world. The results of this investigation are published in a paper called "The Art of Cutting Metals." [1]

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[1] Trans. A. S. M. E., vol. 15, p. 204.

[2] "Transmission of Power by Leather Belting," Trans. A. S. M. E., vol. 31, p. 39.

While Mr. Taylor was carrying forward in a variety of industries the development of his distinctive type of management, but was publishing nothing about its details,[2] Captain Henry Metcalf had been developing independently and describing [3] a system of routing and accounting in the government arsenals, and Mr. Oberlin Smith, president of the Ferracute Machine Company, had presented an interesting paper on the naming of machine parts.[4] When the opportunity came Mr. Taylor helped himself freely to the suggestions in these papers and incorporated them, with considerable modification, into his practice.

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[1] Trans. A. S. M. E., vol. 28, p. 31. An interesting explanation of one of the means by which Mr. Taylor's results are applied in machine shop practice is found in the paper by Mr. Carl G. Barth, the mathematician of the group, on " Slide Rules as Part of the Taylor System," Trans. A. S. M. E., vol. 25, p. 49. An illustration of the effect of such work as a stimulus to the application of thought to management appears in the article by Mr. Charles Day called " The Machine Shop Problem," ibid., vol. 24, p. 1302, which emphasizes the need of coördination, analysis, and a scientific determination of facts.

[2] The only paper by a member of the Taylor group dealing with any detail was Mr. Gantt's " Graphical Daily Balance in Manufactures," ibid., vol. 24, p. 1322, which was a description of the method of scheduling introduced by him at the American Locomotive Works.

[3] " The Shop Order System of Accounts," Trans. A. S. M. E., vol. 7, p. 440. The Cost of Manufactures and the Administration of Workshops, John Wiley & Sons. New York, 1885. 3d edition, 1907.

[4] " The Naming of Machine Parts," Trans. A. S. M. E., vol. 2, p. 366.

Finally, after twenty years' experience, Mr. Taylor submitted to the American Society of Mechanical Engineers the history and methods of his system in what seemed to him to be definite, complete, and coördinated form. This was his famous paper on " Shop Management,"[1] which has been extensively reprinted and translated into French, German, Dutch, Italian, Russian, Lettish and Japanese. In response to the popular interest in the subject brought about by the railroad rate case in 1911, Mr. Taylor was induced to publish a less technical statement under the name *The Principles of Scientific Management.*[2]

" Shop Management " is a considerable expansion of the earlier paper on "A Piece Rate System," and includes much of the detailed methods that had been developed by Mr. Taylor in the intervening years, together with some analysis of the industrial and economic principles involved in his system. The emphasis is laid throughout on the importance of " the coupling of high wages for the workman with low labor cost for the employer," and the eventual interest of the public in the reduced prices resulting from this combination. The difference between the " first class man " and the average workman, the means for selecting or developing the former class, the methods of accurate scientific time study, the philosophy and operation of the task idea in management, the determination of standards, the separation of planning and execution, the development of functional foremanship and the planning department, and steps to be taken in changing from ordinary to " the best type of management," are dealt with extensively. Emphasis is laid on the " evils of soldiering " and the failure of piece rates and premium plans to overcome them; it appears that Mr. Taylor's entire system grew out of his determination to break up this practice.

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[1] Trans. A. S. M. E., vol. 24, p. 1337. New edition. New York, 1911.

[2] Harper and Bros., New York, 1911. A very brief résumé by Mr. Taylor, " Principles and Methods of Scientific Management," is found in the Journal of Accountancy, vol. 12, pp. 117, 181.

The objects sought can be attained, according to Mr. Taylor, most easily by the application of the following principles: —

> (a) *A Large Daily Task.* — Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.
>
> (b) *Standard Conditions.* — Each man's task should call for a full day's work, and at the same time the workman should be given such standardized conditions and appliances as will enable him to accomplish his task with certainty.
>
> (c) *High Pay for Success.* — He should be sure of large pay when he accomplishes his task.
>
> (d) *Loss in Case of Failure.* — When he fails he should be sure that sooner or later he will be the loser by it.
>
> When an establishment has reached an advanced state of organization, in many cases a fifth element should be added, namely: the task should be made so difficult that it can only be accomplished by a first class man.

The rest of the book is an amplification of the methods by which these so-called "principles" are applied.

The Principles of Scientific Management develops the same ideas in a slightly different way. Considerable emphasis is laid on the importance of the substitution of scientific knowledge and incentive on the part of the management for the old reliance on the crudely stimulated initiative of the workman. There is the same discussion of "soldiering," inadequacy of piece and premium systems, and a non-technical review of certain typical methods of the system, with illustrations of the application of scientific method to such diverse operations as shovelling, pig-iron handling, and the cutting of metals.

It is interesting to note in the later book a restatement of the "principles," otherwise referred to as "elements"; —

> *First.* The development of a true science. *Second.* The scientific selection of the workman. *Third.* His scientific education and development. *Fourth.* Intimate friendly coöperation between the management and the men.

In an earlier section of the same book, these "principles" are restated in slightly different form as the "new duties" devolving on the management. In this case they are given as follows: —

> *First.* They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.
>
> *Second.* They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
>
> *Third.* They heartily coöperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.
>
> *Fourth.* There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

It is evident from these statements that Mr. Taylor does not distinguish sharply between principles, duties, and methods, and it is difficult to see why the methods selected for elevation into the class of principles are limited to those given and do not include such fundamental and radical departures as functional foremanship and the task and bonus. This is but another evidence of the fact that the Taylor System is in reality the summation of years of the varied experience of many individuals, which has not even yet been thoroly coördinated and developed into such a system of real principles or laws as characterizes other modern sciences. I believe that the principles are there and that they only await definite and systematic formulation.

In the summer of 1911, the unionized machinists and molders employed at the Watertown Arsenal, where the Taylor System was being developed by Mr. Carl G. Barth, walked out; and on being taken back petitioned that the Labor Committee of Congress investigate the subject and recommend such legislation as would be necessary to protect their interests. A Committee was appointed consisting of Mr. William B. Wilson, the present Secretary of Labor, Mr. William C. Redfield, now Secretary of Commerce, and Mr. John Q. Tilson, " to investigate the Taylor and other systems of management " in government shops. The investigators confined themselves practically to the Taylor System, held hearings at the principal navy yards, and took testimony of workmen, foremen, managers, " efficiency experts," and practically the entire group of Taylor System engineers. The result of their investigation was a brief report that no legislation was necessary. More useful, however, was the publication of the great mass of testimony taken.[1] This report of the hearings is a perfect mine of information in regard to the history, methods, practice, and results of the Taylor System and must be strongly recommended as one of the fundamental sources on the subject.

Another important body of testimony is that introduced by Mr. Louis D. Brandeis as part of the case of the shippers in the " Eastern Rate Case " [2] which is carefully sifted, analyzed and coördinated in Mr. Brandeis' brief.[3]

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[1] Hearings before the Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management. Washington, 1912.

[2] Interstate Commerce Commission Reports, vol. 20, p. 243.

[3] A part of this brief was published under the title Scientific Management and Railroads, New York, 1912. The testimony in this case had no effect on the decision of the Interstate Commerce Commission; but the spectacular and seemingly extravagant form in which some of the testimony was given by persons outside the Taylor group but influenced by it, caught the popular fancy and was responsible for the great publicity the movement suddenly attained.

The most important publication of Mr. Taylor, in addition to those mentioned, is a book prepared by him and Mr. Sanford E. Thompson,[1] which includes, in addition to an acute analysis of concrete construction, certain chapters on time study and valuable tables of unit times determined in accordance with the Taylor methods.[2]

Altho the Taylor System has been applied to many types of industry other than machine shop production in which it originated, little has been published on these applications by those closest to the movement. Among the detailed discussions of other industries, however, must be mentioned the book by Mr. Charles Day,[3] dealing with the construction and layout of factories. Mr. Day points out the influence of the design of the plant upon the efficiency of operation and details the work incident to the planning and building of the plant, from the selection of the site to the construction of buildings and the installation of equipment. Excellent illustrations are given of the best layout and routing of materials in factories of different types. Mr. Gantt has published a short paper dealing with the textile industry,[4] and Mr. Day has pointed out the possibility of application to diverse industries including public service corporations.[5]

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[1] Concrete Costs, John Wiley and Sons. New York, 1912.

[2] Two interesting articles by Mr. Taylor, "Why Manufacturers Dislike College Graduates," Sibley Journal of Engineering, vol. 24, p. 195, and "A Comparison of University and Industrial Methods," Stevens Indicator, vol. 24, p. 37, set forth his convictions in regard to the place of college graduates in manufacturing and particularly his criticisms of their point of view and the handicaps under which they labor and for which their college training is responsible. Chief among these are the inability to concentrate on an undertaking and bring it through to a conclusion, the failure to recognize the importance of punctuality and the value of time and discipline, and a lack of appreciation of the point of view of the workingman.

There is an interesting comment on this in Mr. D. C. Jackson's "Criticism of the Engineering Schools," Stevens Indicator, vol. 27, p. 25.

[3] Industrial Plants. New York, 1911.

[4] "The Mechanical Engineer and the Textile Industry," Trans. A. S. M. E., vol. 32, p. 499.

[5] "Management Principles and the Consulting Engineer," The Engineering Magazine, vol. 41, p. 133.

Growing out of the contributions of Mr. Taylor and his original group are a number of articles dealing with the theory of scientific management as it appears to those who first met it in its developed form. Among the most interesting of these are the Report of the Sub-Committee on Administration of the American Society of Mechanical Engineers.[1] This report, after pointing out the reasons for the present great popular interest in the subject, attempts to find the one basic principle in the movement, and discovers it in "the transference of skill." Just as the introduction of machinery meant "the transference of skill from the inventor or designer to the power-driven mechanism," so scientific management is the transference of skill from the manual worker to the planning department and functional foremen, resulting in the saving of labor and the increased output and reduction of cost. The report includes a collection of interesting attempts to state the underlying principles of scientific management.

Mr. Forrest E. Cardullo[2] has compared "conventional," "systematic," and "scientific" management, with illustrations of administration of the various types. Then follows a discussion of the causes of current inefficiency, which may be grouped into three classes: those which are chargeable primarily to the employer, those which are chargeable primarily to the workman, and those which are chargeable primarily to our political and industrial system. They include mental laziness, prejudice against so-called "non-productive" labor, timidity of capital, lack of foresight and adaptability, mental inertia, lack of study of industry, inefficient wage systems, and avarice, on the part of the management;

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[1] "The Present State of the Art of Industrial Management," Journal, A. S. M. E. May, 1913, p. 871.

[2] "Industrial Administration and Scientific Management," Machinery, vol. 18, pp. 843, 931; vol. 19, p. 18.

and on the part of the workmen, disinclination to work at other than their accustomed pace, lack of ambition, mental laziness, and enmity to their employers; and on the part of the political and industrial system, periodical depressions, seasonal variations in work, intense individualism, wasteful competition, and sudden changes in laws, customs, fashions, and social conditions. The paper closes with an enumeration of the objections to scientific management and the answers to them and is, on the whole, one of the best contributions to the subject.

Lieut. G. J. Meyers [1] has made an interesting attempt to deduce and formulate " laws " of management. He gives the following synopsis of laws: —

Law I. — What to do.
Law II. — Instructions before work starts.
Law III. — Machines and tools.
Law IV. — Workmen.
Law V. — Insure instructions are carried out.
Law VI. — Costs.
Law VII. — Study for improvements.

Each statement begins: " It is necessary in any activity." Thus Law I is in this form: " It is necessary in any activity to have a complete knowledge of what is to be done and to prepare instructions as to what is to be done before the work is started," and so for each topic in the synopsis. The formulation of each law is followed by a brief statement of the reasons for it and the method of its application. The paper is a highly interesting essay in the formulation of industrial principles.[2]

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[1] " The Science of Management," Journal of the American Society of Naval Engineers, vol. 23, p. 994.

[2] To these should be added the following: Mr. H. P. Kendall's " Management: Unsystematized, Systematized and Scientific," Scientific Management, Tuck School Conference, 1912, p. 112; reprinted in Industrial Engineering, vol. 10, p. 374, a comparison of the types of management mentioned, based on the writer's personal experience

The present writer[1] has pointed out that the time study methods of the Taylor System provide a definite basis for one side of the wage bargain: to wit, the content of a day's work, but makes no attempt to determine the equivalent day's wage, except to provide a means through the bonus or differential rate for the application of the principle that superior service should be paid at a superior rate.

M. LeChatelier's Introduction to the French translation of *The Principles of Scientific Management* discusses the fear both on the part of the employers and the workmen, that the radically new methods of scientific management will bring about critical economic problems of readjustment; and lays this fear to ignorance of the gradual working out of economic changes.

Mr. Morris L. Cooke, now director of Public Works in the City of Philadelphia, and one of the later additions to the original Taylor group, was retained by the Carnegie Foundation to make an investigation of academic efficiency from the point of view of an industrial administrator.[2] Mr. Cooke discusses current types of university organization, the college teacher as a producer, research, the economical use of buildings, functional activities, financial administration, and student administration. According to him, there is no present gauge to efficiency in academic work and, while recognizing that the product of the university is of so

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with the last two and a wide acquaintance with the first. Mr. Tracy Lyon's brief review of principles in "Scientific Industrial Operation," in "Technology and Industrial Efficiency," p. 200, New York, 1911. Reprinted in Iron Age, vol. 87, p. 922, and in Industrial World, vol. 45, p. 464. Mr. A. Hamilton Church's "The Meaning of Scientific Management," Engineering Magazine, vol. 41, p. 97, which is one of numerous suggestive but unsuccessful attempts to find "the one" principle underlying the movement. Finally, the editorial, "Scientific Management More Than a Labor Problem," Industrial Engineering, vol. 11, p. 467, pointing out the inclusiveness of the method.

[1] C. B. Thompson, "Relation of Scientific Management to the Wage Problem," Journal of Political Economy, vol. 21, p. 630.

[2] "Academic and Industrial Efficiency," Carnegie Foundation Bulletin No. 5. 1910.

intangible a nature as not to be subject to exact measurement, he points out the possibility of the application of a unit, the student-hour, to the measurement of administrative efficiency. His discussion is brought to bear in detail upon the administration of a physics department and includes an application of some of the methods of industrial administration.[1]

Interesting suggestions for the partial or complete application of the Taylor System to varied industries are made by Mr. F. B. Gilbreth [2] when he shows the revolutionary result of the application of motion study to a trade so ancient as laying bricks, and by Mr. B. M. Ferguson [3] who details the favorable results of his experiments, particularly in its application to outdoor construction.

The success of the application of the Taylor System to the government arsenals drew the attention of engineers in the Navy to the possibility of its application to their branch of the service. This is discussed by Mr. C. S. Brewer [4] and by Lieut.-Commander W. B. Tardy.[5] Particularly interesting is the Report of the Civilian Expert Board [6] on Industrial Management of United States Navy Yards. This Board, appointed by the Secretary of the Navy and consisting of Messrs. H. L.

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[1] The following articles may be taken as samples of the comment provoked by this study: "Educational and Industrial Efficiency," Science, N. S., vol. 33, p. 101 by Richard C. Maclaurin, President of the Massachusetts Institute of Technology, who is apprehensive that the methods proposed by Mr. Cooke will consume too much of the time of officers of instruction and will tend to distract attention from the fundamental purpose of a university; "Educational or Administrative Efficiency," Engineering Magazine, vol. 40, p. 606 (anonymous); and "Scientific Management and Academic Efficiency," The Nation, vol. 93, p. 416 by Professor A. G. Webster.

[2] Bricklaying System. New York and Chicago, 1909.

[3] "The Application of the Taylor System to Gas Works," American Gas Light Journal, vol. 95, p. 225, and Progressive Age, vol. 29, p. 830.

[4] "Scientific Management in the Army and Navy," World's Work, vol. 23, p. 311.

[5] "A Plea for a Standard Organization of the Engineer Division Aboard Ship," etc., Journal of the American Society of Naval Engineers, vol. 23, p. 681.

[6] Prepared by direction of Hon. George von L. Meyer, Secretary of the Navy. Washington, 1912.

Gantt, Harrington Emerson, and Charles Day, investigated the present functions and conditions of navy yards. They discussed the efficiency of their management in comparison with that of industrial plants and made certain recommendations in regard to the nature of the work properly to be performed in navy yards and "that scientific management be introduced and perpetuated in the navy yards which it is decided to operate."

The most ambitious attempt to apply the Taylor principles to selling has been made by Mr. Charles W. Hoyt.[1] He describes such modern methods as training classes, salesmen's conventions, standardized talks, and outlines rather inadequately the application of the scientific method of approach to the problems of salesmanship.[2]

The growing realization that perhaps the greatest economic waste from which we suffer is due to the inefficient management of household economy has resulted in some thought being given to the working of the Taylor principles in domestic management. The most suggestive article on this subject is that by Mr. J. B. Guernsey,[3] which, however, is rather too vague and theoretical to be of practical service.

It is not strange that the best known and most popular books on the principles of scientific management are not those written by its originator and his co-workers; they are the product of persons who have been influenced by them and whose gift of expression is more highly developed. Foremost among these are two books by Mr. Harrington Emerson,[1] marked by a breadth of interesting information, and a capacity for inspiring, almost poetic, elucidation, which have made them the most popular expositions of the subject.[2]

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[1] Scientific Sales Management. New Haven, 1913.

[2] Other articles dealing briefly with this subject are Mr. Amasa Walker's "Scientific Management Applied to Commercial Enterprises," Journal of Political Economy, vol. 21, p. 388, and Mr. J. George Frederick's "Applying the Science of Management to Selling," Industrial Engineering, vol. 12, p. 204.

[3] "Scientific Management in the Home," Outlook, vol. 100, p. 821.

Mr. Emerson discusses certain typical inefficiencies and their significance, the causes of national industrial prosperity, the strength and weakness of existing systems of organization. He then proceeds to an exposition of his own method of line and staff organization, the determination and realization of standards, cost accounting, the location and elimination of wastes, and the Emerson bonus system. His method differs from that of Mr. Taylor in two respects: in the first place, in the line and staff organization, the staff consisting of the experts occupies an auxiliary and advisory relation to the management, whereas in the Taylor System, the experts are the functional foremen and are an integral executive part of the organization; in the second place, the Emerson bonus proceeds on the rough determination of a standard efficiency which he calls 100%; the workman who attains 67% or less gets his guaranteed day wages, and is paid a bonus on a sliding scale for every increase in the percentage of efficiency; at 100% the bonus amounts to 20% of his wages and 1% is added for each additional 1% of efficiency. As the task is not originally so accurately and thoroly set as in the Taylor System, the workman can, and frequently does, exceed the 100% mark.

Mr. Emerson states the principles of management as follows: (1) clearly defined ideals; (2) common sense; (3) competent counsel; (4) discipline; (5) the fair deal; (6) reliable, immediate, and adequate records;

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[1] Efficiency, New York, 1910, and The Twelve Principles of Efficiency, 1912.

[2] Two other simplified expositions worth mentioning are the Primer of Scientific Management, New York, 1912, by Mr. F. B. Gilbreth, and the misnamed "Psychology of Management," Industrial Engineering, vol. 11, pp. 343, 429; vol. 12, pp. 13, 65, 116, 155, 199, 248; vol. 13, pp. 18, 66, 113, 161, 213, by Mrs. L. M. Gilbreth."

(7) despatching; (8) standards and schedules; (9) standardized conditions; (10) standardized operations; (11) written standard-practice instructions; (12) efficiency reward. Most of these are not by any means peculiar to scientific management, nor can it be said that Mr. Emerson's application of them is distinctively original. Incidentally it is interesting to note the gradual change from Mr. Emerson's acknowledgment of indebtedness to Mr. Taylor in certain discussions in the American Society of Mechanical Engineers to the reversal of this position in his later published work.

Out of the large number of books written within the last five years on the general subject of factory administration, four of the most important devote attention to a discussion of scientific management and show in general considerable influence by it. The most noteworthy of these are by Mr. Charles B. Going[1] and Mr. Dexter Kimball,[2] — these two are especially valuable for the setting they give scientific management in the development of modern administrative methods; Messrs. Galloway, Hotchkiss and Mavor;[3] and Mr. Hugo Diemer.[4]

It is natural that such a radical and far-reaching movement as scientific management should meet criticism. It has in fact been a veritable storm-centre. Much of the criticism is aimed at details and will be discussed later; but the following articles go for the system root and branch and should properly be enumerated here. The most comprehensive criticism is that by Admiral John R. Edwards,[5] who sums up the comments of most of the adverse writers, and adds on his own account that scientific management does not cover the whole of management, and that in any case management is an art rather than a science, that the Taylor System antagonizes the workmen and neglects the personal equation, and that whatever advantages have come from it have been incidental by-products. Another severe criticism is that by Mr. A. Hamilton Church,[1] who attacks particularly certain extracts from Mr. Taylor's writings, leading to the conclusion that Mr. Taylor does not show a science.[2] Mr. Church and Mr. L. P. Alford [3] undertook to enumerate the principles of management and pointed out the place of the Taylor System in them.[4]

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[1] Principles of Industrial Engineering. New York, 1911.

[2] Principles of Industrial Organization. New York, 1913.

[3] Business Organization. New York, 1912.

[4] Factory Organization and Administration. New York, 1910.

[5] "The Fetishism of Scientific Management," Journal of American Society of Naval Engineers, vol. 24, p. 355.

As already stated, most of the popular articles on the subject are obviously journalistic and ephemeral. The most spectacular discoveries of Mr. Taylor and his co-workers lend themselves easily to "popular" treatment; and the possible results of the application of the stop-watch and the micrometer appeal effectively to the imagination of magazine and newspaper writers. Most of their work contains nothing new or significant. The few popular articles of real value are listed below.[5]

[1] "Has Scientific Management Science?" American Machinist, vol. 35, p. 108.

[2] The same point is made in an editorial called "The Science of Management Defined, and the Scope of this Science," Engineering and Contracting, vol. 39, p. 339.

[3] "The Principles of Management," American Machinist, vol. 36, p. 857. Reviewed by Mr. D. S. Kimball and Mr. J. Calder, ibid., p. 965.

[4] Other important general criticisms are those by Mr. Dexter S. Kimball, "Another Side of Efficiency Engineering," American Machinist, vol. 35, p. 263, developing briefly some of the social and economic implications of the movement and calling attention to the absence of a discussion of distribution; by Mr. H. G. Bradlee, "A Consideration of Certain Limitations of Scientific Efficiency," in "Technology and Industrial Efficiency," p. 190, New York, 1911; reprinted in Stone & Webster's Public Service Journal, vol. 8, p. 323, pointing out that for the most effective application conditions must be uniform, work repetitive and the area of operations small; by Mr. E. C. Peck, "Systematic versus Scientific Management," Iron Age, vol. 88, p. 364, drawing attention to the scarcity of real experts and the dangers of inexpert work; and by Mr. James R. Johnson, "A Manager's View of the Taylor System," American Machinist, vol. 34, p. 885, presenting the point of view of the typical successful manager, that we should let well enough alone.

[5] The following contain good enough ideas, well enough expressed, to warrant listing and recommending them: Mr. A. G. Popke's "The Relations of Capital, Labor and

2. SCIENTIFIC MANAGEMENT IN OPERATION

As yet nothing has been published summarizing the results of the application of scientific management in any large proportion of the plants which are using it. The nearest approach to a review of its present status is in the Report of the Sub-Committee on Administration of the American Society of Mechanical Engineers, referred to above. It is significant that one of the signers and, I believe, the actual writer of this report is Mr. L. P. Alford, mentioned above as one of the critics of the movement. Mr. Alford has written another excellent article,[1] based on the experience of a well-known Philadelphia company. Mr. A. W. Shaw, editor of the magazine *System*, gives a good brief review,[2] describing the work of the system at the Tabor Manufacturing Company in Philadelphia, and suggesting the method of its application to business problems in general and the results that might reasonably be expected from it. The experience of the Link Belt Company of Philadelphia is described by Mr. James M. Dodge, its president,[3] and a complete and detailed

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Efficiency in Manufacturing," Engineering Magazine, vol. 43, p. 857, pointing out the necessity of increasing efficiency; Mr. E. Perry's " The Outsider and the Busy Business Man," ibid., vol. 40, p. 249, answering the old saw that improvement should come from the inside and not from the outside expert; a series of articles by Mr. E. M. Wooley. — " The One Best Way," System, vol. 20, pp. 227, 356, 460, 614; " Scientific Management in the Office," ibid., vol. 21, p. 3; " Getting Out the Mail," ibid., vol., 21, p. 284; " The Wanton Waste of Labor," ibid., vol. 21, pp. 13, 173, " Lost Motions in Retail Selling," ibid., vol. 21, pp. 366, 465, — well written and suggestive; Mr. H. S. Philbrick's " Scientific Management," World To-day, vol. 21, p. 1167, developing the idea that scientific management is a resumption of the direct oversight over production which had gradually vanished; an anonymous article, " What is Scientific Management, and What Does it Do ? " Industrial Engineering, vol. 9, p. 1; an article, also anonymous, on " Efficiency Program," Independent, vol. 70, p. 739; an anonymous article entitled " Aspects of Scientific Management," The Nation, vol. 92, p. 464; and an excellent article by Mr. F. B. Copley, " How it Works: What Manufacturers and Workmen are Getting out of Scientific Management," American Magazine, vol. 75, p. 11, summarizing the results of an extensive investigation and approved personally by Mr. Taylor.

[1] " Scientific Management in Use," American Machinist, vol. 36, p. 548.

[2] " Scientific Management in Business," Review of Reviews, vol. 43, p. 327.

[3] " A History of the Introduction of a System of Shop Management," Trans. A. S. M. E., vol. 27, p. 720.

explanation of the operation of the Taylor System in that plant is given by Lieut. Frank W. Sterling.[1] The experience of the same plant is the basis of an article by Mr. C. W. Adams, its superintendent.[2] The same methods, as worked out by the Midvale Steel Company, are described by Mr. H. L. Arnold.[3] An excellent description of the early application of the System at the Bethlehem Steel Works is published by Mr. H. L. Gantt,[4] and the story of its introduction and results at the Tabor Manufacturing Company is told by Mr. Wilfred Lewis, the president of the company.[5] The methods described in Mr. H. P. Kendall's paper [6] are in the main those of the large printing and binding establishment of which he is the general manager. Mr. Carl G. Barth gives an interesting anecdotal account.[7] Lieut.-Commanders W. B. Tardy [8] and A. M. Cook [9] give the results of the application of the principles of the system to gunnery practice and to the administration of a navy yard. The same subject is also dealt with by Mr. Holden A. Evans in a series of articles.[10]

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[1] "The Successful Operation of a System of Scientific Management," Journal of American Society of Naval Engineers, vol. 24, p. 167.

[2] "The Differential Piece Rate," American Machinist, vol. 34, p. 18.

[3] "Pre-eminent Success of the Differential Piece Rate System," Engineering Magazine, vol. 12, p. 831.

[4] "A Practical Application of Scientific Management," Engineering Magazine, vol. 41, p. 1.

[5] "An Object Lesson in Efficiency," in "Technology and Industrial Efficiency," p. 173. New York, 1911.

[6] "Management: Unsystematized, Systematized, and Scientific," Scientific Management, Tuck School Conference, 1912, p. 112. Abstract in Industrial Engineering, vol. 10, p. 374.

[7] "Betterment of Machine-Tool Operation by Scientific Metal Cutting," Engineering Magazine, vol. 42, p. 586.

[8] "Scientific Management and Efficiency in the United States Navy," Engineering Magazine, vol. 41, p. 545. American Review of Reviews, vol. 44, p. 229.

[9] "Scientific Management Methods at a Naval Magazine," Engineering Magazine, vol. 42, p. 75.

[10] "Reduction in Cost of Navy Yard Work," American Machinist, vol. 33, p. 1200; "General Instruction for Machine-Shop Methods," ibid., vol. 31, p. 610; "Detailed Instruction for Machine-Shop Methods," ibid., p. 645; "Do Taylor's Methods In-

Two extended and complete accounts are those by Mr. Charles B. Going and by General William Crozier. Mr. Going's article[1] describes the results achieved by Mr. Emerson in the application of his form of scientific management to the Santa Fe Railroad, and presents the conclusions of a disinterested spectator removed from the stress of the conflict between the railroad managers and their critics. It will be discussed in more detail in the next section. The reports by General Crozier on the application of the Taylor System to government arsenals[2] are exceptional in that they give detailed costs and comparisons to an extent not considered practicable by the managers of private concerns. The 1911 report gives an excellent brief résumé of the introduction of the system in the Watertown Arsenal, and a rather full demonstration of the statement that "the practical effect of these methods at the Watertown Arsenal has been a material reduction in the cost of general manufacture at that place," and describes the beginning of the trouble at that Arsenal with the molders and machinists. The 1912 report pursues the same subject and quotes comparisons of the cost of production at Watertown and other Arsenals where the system had begun to be installed with bids on the same items from outside concerns. The appendix to the 1913 report gives the recent petition of the Watertown employees for the abolition of the Taylor System, and the extended and conclusive reply of General Crozier.

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crease Production?" ibid., vol. 34, p. 1133; "Output under Scientific Management," ibid., p. 1202.

The application to an automobile repair shop of the modification of the Taylor System used by Mr. Emerson and his disciples is described by Mr. A. Flack in "Machine-Shop Experience with the Principle of Efficiency Reward," Engineering Magazine, vol. 41, p. 641.

[1] "The Methods of the Santa Fe," Engineering Magazine, vol. 36, p. 909; vol. 37, pp. 9, 225, 337, 541.

[2] Reports of the Chief of Ordnance for 1911, 1912, and 1913. Washington.

3. Scientific Management and the Railroads

In the Eastern Rate Case, the application of the railroads to the Interstate Commerce Commission for permission to raise freight rates was met by the shippers, under the advice of Mr. Louis D. Brandeis, with the counter-argument that, instead of raising the rates to spend more money, they should make their operation efficient to get more out of their present expenditure. In the course of the hearings, the following testimony was introduced: —

> Mr. Brandeis. You have been quoted, Mr. Emerson, as stating that in your opinion, by the introduction of proper efficiency system of scientific management, the railroads of the United States could effect an economy of perhaps $300,000,000 a year, or not less than $1,000,000 a day.
>
> Mr. Emerson. That is correct — that is, I have been quoted as having stated that.
>
> Mr. Brandeis. Is it your opinion that that is the fact ?
>
> Mr. Emerson. At least that.[1]

Altho, as stated above, the decision of the Commission was not affected by this testimony, the publicity it received stirred up an intense discussion, much of which on the part of the railroads showed signs of the spirit of the man who has been stung.

The best summary of the testimony bearing on this subject is by Mr. Louis D. Brandeis,[2] who has analyzed the meaning, the requirements, and the effects of scientific management, and who groups the evidence of the witnesses in accordance with the analysis. In an earlier article[1] Mr. Harrington Emerson had pointed out that, in his opinion, the railroads could save $300,000,000 a year, and his articles[2] suggest the method by which he approaches this conclusion. Mr. Emerson had been retained by the Santa Fe to develop his form of scientific management in part of their work and the results are described by Mr. Charles B. Going,[3] who outlines the problems of the road and describes Mr. Emerson's treatment of the stores keeping, shop order and works order systems, maintenance of motive power, the bonus system, the apprentice system, and relations with the employees. The bonus system is further described by Mr. Fred H. Colvin, editor of *The American Machinist*.[4]

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[1] Brief on Behalf of Traffic Committee of Commercial Organizations of the Atlantic Seaboard, before the Interstate Commerce Commission, *re* Investigation of Proposed Advances in Freight Rates by Carriers in Official Classification Territory, p. 92.

[2] Scientific Management and Railroads. New York, 1911. Ably reviewed by Mr. Edward D. Jones in the American Economic Review, vol. 1, p. 833.

Severe criticism of Mr. Emerson and his methods was made by Mr. Wilson E. Symons.[5] Mr. Symons attacks Mr. Emerson's statistics, shows the impossibility, in his opinion, of a million dollar a day saving, denies that Mr. Emerson's work on the Santa Fe was of any value, and gives examples of what he considers real railroad efficiency. Whatever may be the worth of Mr. Symons' statistics, it is evident to any one acquainted with scientific management that he knows practically nothing of the latter subject, and the paper is valuable mainly by reason of the discussion participated in by many well-known railroad men.[1]

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[1] " Preventable Wastes and Losses on Railroads," Railway Age Gazette, vol. 45, p. 12.

[2] " How Railroad Efficiency Can be Measured," Engineering Magazine, vol. 42, p. 10; and " The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fe," American Engineer and Railroad Journal, vol. 81, p. 221. Mr. Emerson's work in the Santa Fe work-shops is praised by Mr. W. J. Cunningham in the discussion of Mr. Taylor's address on scientific management before the New England Railroad Club (Oct. 10, 1911).

[3] " Methods of the Santa Fe," Engineering Magazine, vol. 36, p. 909; vol. 37, pp. 9, 225, 337, 541.

[4] " How Bonus Works on the Santa Fe," American Machinist, vol. 36, pp. 7, 165. See also two articles by Mr. Charles H. Fry, associate editor of the Railway Age Gazette, in the Railway Age Gazette, vol. 41, pp. 476, 504, followed by an editorial on the same subject, vol. 45, p. 413. Mr. Fry outlines the organization of the work on that road and illustrates with charts and statistics the results attained, particularly in machine-shops.

It is generally understood that the influence of Mr. Emerson pervades the book of Mr. H. W. Jacobs, Betterment Briefs, New York, 1909. 2d ed., dealing with Santa Fe machine shop improvements, reviewed in the Railway Age Gazette, vol. 47, p. 1192.

[5] " The Practical Application of Scientific Management to Railway Operation," Journal of the Franklin Institute, vol. 173, pp. 1, 140, 271, 365. See also his reply to an editorial criticism of his own paper in the Railway Age Gazette, vol. 51, p. 1107.

The bitterness of the reaction by some railroad men is illustrated in a series of anonymous articles,[2] with such titles as "Extravagant Claims," "Impractical Theories," "Neglect of Human Element," "Unscientific Method and Impatience for Results," and "Neglect of Large Factors," which criticize severely some of the practices the writer had apparently met with. It is unfortunate that no means of identification are given, and there is apparently some point to the comment in the letter by Mr. F. L. Hutchins [3] to the effect that the writer of the articles was mistaken in his classification of "efficiency men." The articles are well worth reading, however, as they appear to describe accurately the kind of things done by the many ill-prepared and inexperienced practitioners of "efficiency."

The objection to scientific management on the railroads on the ground that interference of the labor unions makes it impossible, is voiced by Mr. J. O. Fagan [4] who reiterates his point that the difficulty with the railroads is the employees.[1]

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[1] In the same Journal appeared a defence of Mr. Emerson by Mr. C. J. Morrison, "Letter on Scientific Management," Railway Age Gazette, vol. 50, p. 214, and a fair criticism with acknowledgment of variation of the Emerson and the Taylor methods in an anonymous article on "What is Scientific Management?" ibid., vol. 50, p. 839. Two good editorials on the subject are contained in The Railway Age Gazette: one of which, vol. 50, p. 18, holds that "the basic principles underlying scientific management are correct," and the other, vol. 50, p. 210, that "the value and effectiveness of scientific time study cannot be questioned." Some justification of Mr. Emerson's criticism of the efficiency of the railroads may be found in an article by Mr. L. C. Fritch, a well recognized railroad expert, on "Opportunities for Economy on Railways," ibid., vol. 51, p. 1059.

[2] "The Mistakes of the Efficiency Men," Railway Age Gazette, vol. 50, pp. 29, 230, 391, 849, 1059.

[3] Railway Age Gazette, vol. 50, p. 268.

[4] "The Dream of Scientific Management on Railroads," Journal of Accountancy, vol. 12, p. 1.

Other fundamental objections to the application of scientific management to railroads are discussed by Professor W. J. Cunningham.[2] After stating the principles of the Taylor System, he discusses the testimony of Mr. Emerson and points out the vagueness of the methods proposed by him. He criticizes severely Mr. Emerson's statistics and particularly the method by which he arrives at the one million dollar a day saving. Acknowledging the success of scientific management in commercial undertakings, he points out four essential differences between manufacturing establishments and railroads: (1) area and extent of activity; (2) nature of product and output; (3) relations with the public and the government; and (4) relations with labor unions, — any one of which, in his opinion, makes an application of the system to railroads impracticable. He then shows that the railroads have in fact for some time been applying scientific management of their own kind, and that the remedy for their administrative difficulties lies in a further application of the same methods by better and more efficient men.

Another railroad man, Mr. C. deL. Hine, in a stimulating and suggestive book,[3] develops the thesis that specialization has already been carried too far on the railroads and that what they need is decentralization rather than the increased centralization characteristic of scientific management.[1]

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[1] See also the discussion between him and Mr. E. H. Abbott in " Humpty Dumpty's Question, and its Answer," Outlook, vol. 97, p. 543. The subject is also dealt with in an anonymous article in the Iron Age, " Railroad Efficiency and the Labor Unions," Feb. 23, 1911; and the responsibility for the problem is traced in an anonymous article, " Genesis of Railway Brotherhoods," Railway Age Gazette, vol. 50, p. 782; the point is also mentioned by Mr. W. D. Hines in " Scientific Management for Railways," Nation, vol. 91, p. 576.

[2] " Scientific Management in the Operation of Railroads," Quarterly Journal of Economics, vol. 25, p. 539.

[3] Modern Organization. New York, 1912.

One of the principal arguments of the railroads was that, so far as scientific management was applicable to railroading, it was already being applied, as was pointed out in Mr. Cunningham's article already referred to. An attentive study of the examples given by the railroad writers, however, shows that in the main they have mistaken isolated applications of scientific methods for the systematized organization of administration, which is meant by " scientific management." [2]

In the meantime, practical heed is being given to the possibility of making some form of application of the new system to railroading. For obvious reasons little is being published on this point, and any reference to the fact that the methods are those of Mr. Taylor or Mr. Emerson is carefully avoided.[3]

The fact seems to be, as expressed [4] by Mr. C. C. Leech, that " the efficiency men simply got in wrong " and that when personalities came to be forgotten, the railroad managers were as alive as any one to the possibilities of improvement.[5] As evidence of the truth of this,[1] may be cited the work in the Canadian Pacific Shops where scientific methods have been installed by Mr. Gantt and maintained and developed by Mr. Vaughan, a leading railroad expert.[2]

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[1] Attention should also be called to two editorials in the Railway Age Gazette, vol. 50, p. 265 and p. 387.

[2] See Mr. C. B. Brewer's " Substitute for the Rate Increase," etc., Scientific American, vol. 104, p. 596; Mr. B. S. Hinckley's " The Scientific Thought Applied to Railroad Problems," in " Technology and Industrial Efficiency," p. 181. New York, 1911; Mr. S. M. Felton's " Scientific Management of American Railways," ibid., p. 221; and an anonymous article, " The Comparative Merits of Functional and Geographical Systems of Organization," Engineering News, vol. 64, p. 692.

[3] This is shown in the articles by Mr. W. J. Harahan on " Scientific Management," Railway Age Gazette, vol. 50, p. 212; by Mr. M. H. C. Brombacher on " Application of Scientific Management to a Railway Shop," ibid., vol. 51, p. 23; by Messrs. H. F. Stimpson, L. W. Allison, J. S. Sheafe, and C. J. Morrison, on " Application of Scientific Management to a Railway Shop," ibid., vol. 51, p. 33; and by Mr. B. A. Franklin on " An Efficiency Experiment Station for the Railroads," Engineering Magazine, vol. 42, p. 1.

[4] " A Letter on Efficiency," Railway Age Gazette, vol. 51, p. 221.

[5] An anonymous article, " Scientific Management of Railway Shops," Machinery, vol. 10, p. 16, calls attention to the steps taken by railroads to investigate efficiency as a result of the agitation; and an editorial in Engineering and Contracting, " The Railways and Scientific Management," vol. 35, p. 379, points out that scientific management is now being applied to the railroads.

4. METHODS

In current discussions of scientific management so much emphasis has been laid upon such things as time study, motion study, functional foremanship, instruction cards, and slide rules, that there is serious danger of these mechanisms of the system being taken for the system itself. With the warning, however, that detailed methods, either separately or in mere aggregation, are not scientific management, it is worth while to report the best of the articles and books which have appeared describing these methods. Nor is it superfluous to warn readers of these articles that the methods dealt with are so technical in their nature that their successful practice requires not only an expert in the methods used, but an expert in the proper adjustment of these methods to each other and particularly to the entire spirit of scientific management.

There is an excellent series of articles dealing with the method of approach to the system,[3] most of which are amplifications of the warnings so liberally scattered through Mr. Taylor's own books. The point of all of them is that no management should undertake to develop the Taylor System in its plant, unless it is prepared for a very considerable expenditure of time, money, and effort and a slow process of mental revolution on the part of itself and its employees.

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[1] In spite of the conclusion by Mr. George J. Burns in "Notable Efficiencies in Railway Machine-Shop Operation," Engineering Magazine, vol. 42, pp. 161, 386, 616, that the setting of standards in a railroad shop is impossible.

[2] "Canadian Pacific Shop Management," American Machinist, vol. 35, p. 1164; and "Scheduling Locomotive Repair Work on the Canadian Pacific Railway," Industrial Engineering, vol. 8, p. 380.

[3] The best of these are Mr. James M. Dodge's "The Spirit in Which Scientific Management should be Approached," Scientific Management, Tuck School Conference, p. 142; abstract in Industrial Engineering, vol. 10, p. 350; Mr. H. K. Hathaway's "Prerequisites to the Introduction of Scientific Management," Engineering Magazine, vol. 41, p. 141; the editor of Industrial Engineering has an excellent editorial on "Installation of Scientific Management," Industrial Engineering, vol. 10, p. 301; and there is a good article in the Iron Age by Mr. E. M. Taylor, "Modern Methods and the Business Specialist," vol. 84, p. 184. There is a suggestive and humorous account of the way not to do it, called "Echoes from the Oil Country," by Mr. W. Osborne, Ameri-

Of the growing shelfful of books on the entire subject, the best is of course Mr. Taylor's *Shop Management* referred to above. This book deals mainly with machine shop practice, but the principles and methods are developed in such a way that their application to other types of industry is not difficult if made by those sufficiently trained. The book on *Concrete Costs* by Mr. Taylor and Mr. Sanford E. Thompson, referred to above, applies scientific management to concrete construction. The other books detailing methods of application are written by men who have studied more or less with Mr. Taylor, or have been strongly influenced by his methods. One of the best of these is by Mr. F. A. Parkhurst,[1] which includes a series of articles reprinted from *Industrial Engineering*. The book includes an outline of the organization of a plant under scientific management, and detailed statements of the functions of all the principal functional foremen, an analysis of routing, stores systems and time study, a discussion of standardization and many illustrations of forms and appliances. The methods described are based on the practice of the Ferracute Machine Company, and differ only slightly from the approved practice of the original Taylor group. Another excellent book by Mr. Holden A. Evans, formerly Commandant

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can Machinist, vol. 34, p. 1036; and another by Mr. H. K. Hathaway, in the discussion of Mr. Taylor's " Art of Cutting Metals," Trans. A. S. M. E., vol. 28, p. 281.

[1] Applied Methods of Scientific Management. New York, 1912.

of the Mare Island Navy Yard,[1] deals particularly with machine shop, smith shop, and woodworking shop methods, and illustrates reductions in cost accomplished by these methods in Navy Yards under the author's supervision. In addition to its treatment of costs, it is concerned mainly with such developments in the direction of scientific management as may be undertaken by a manager not specially trained in the Taylor methods.[2]

The application of scientific management to foundries and machine shops is given in some detail by Mr. C. E. Knoeppel[3] in a series of articles reprinted from the *Engineering Magazine*. This is an interesting and well-written description of the application of scientific management as interpreted by Mr. Emerson and his disciples.[4]

The best articles describing the functions of the planning department are those by Mr. H. K. Hathaway,[5] in which he outlines briefly the duties of the functional foremen and illustrates the practical working of the extension of specialization to mental and supervisional work.

Perhaps the most distinctive feature of scientific management in the popular conception of the term is its time study. Current methods of time study, however, are frequently confused with the Taylor method. In ordinary practice watches are often used to determine roughly the time an operation usually takes, and the result is sometimes made the basis of a piece rate. This type of time study is known to the Taylor group as an " over-all " study and is never used by them. The Taylor method consists in the analysis of operations into their elementary units and the determination of the best methods and time for the performance of each of these units and their summation into a total time for the entire job.

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[1] Cost Keeping and Scientific Management. New York, 1912.

[2] There is a good statement of underlying principles in Mr. Evans' article " Scientific Factory Management," American Machinist, vol. 33, p. 1108. The " System " Company of Chicago has published a little book, " How Scientific Management is Applied," Chicago, 1911, consisting of a series of reprints of System articles.

[3] Maximum Production in Machine-Shop and Foundry. New York, 1911.

[4] Attention may be called to articles by Mr. Holden A. Evans, " Detailed Instructions for Machine Shop Methods," American Machinist, vol. 31, p. 16, and " An Analysis of Machine-Shop Methods," ibid., p. 468, and by Mr. Frederick A. Waldron, " Modern Methods of Shop Management," Iron Age, vol. 85, p. 982, which are almost too brief to be very useful.

[5] " The Planning Department," Industrial Engineering, vol. 12, pp. 7, 53, and 97. With these should be read an anonymous article, " The Foreman's Place in Scientific Management," Industrial Engineering, vol. 9, p. 197; and the criticism of functional foremanship in Mr. John Calder's " The Production Department," Transactions, The Efficiency Society, vol. 1, p. 155.

The best descriptions of elementary time study as practised by the Taylor group of engineers are those by Mr. H. K. Hathaway[1] and by Mr. H. W. Reed.[2] A comparison of these articles with the tables of operating times given in Babbage's *Economy of Manufactures* will effectively dispose of any claim that the Taylor methods were anticipated by Babbage.

The practice of time study involves motion study. The aim of motion study is to determine the most effective motion to accomplish a desired result; and one of the elements in the determination of its effectiveness is the time it takes to execute it. Time study and motion study, therefore, go hand in hand, but it is not impossible to make an effective and profitable motion study without the use of any timing device. There is an interesting foreshadowing of modern motion study in an experiment carried out in 1837. This was described by Thomas Lefevre,[3] a foreman in the famous printing plant of the Didots, who was struck with the fact that the traditional layout of the printer's case was not the one best adapted to the setting of type, in that usually the compositor had to reach farthest for the most frequently used letters. Lefevre, therefore, redesigned the case with a view to the maximum economy of effort and, after a test of both layouts, adopted the revised case for his plant. After some years of struggle with the traditions of the printing fraternity, the new case was abandoned; but the experiment is a good early illustration of the application of motion study.

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[1] " Elementary Time Study as a Part of the Taylor System of Scientific Management," Industrial Engineering, vol. 11, p. 85.

[2] " A Time Study under the Taylor System," American Machinist, vol. 35, p. 689. A good article is that by Mr. N. E. Adamson, Jr., " The Taking of Time Study Observations," Industrial Engineering, vol. 10, p. 439.

[3] Guide Pratique du Compositeur. Paris, 1883 (nouvelle edition).

The best descriptions of motion study as such are given by Mr. Frank B. Gilbreth.[1] Mr. Gilbreth endeavors to list the variables affecting the efficient performance of manual work, and to point out the extent of their influence. They are classed as variables of the worker, including anatomy, brawn, contentment, creed, earning power, experience, fatigue, habits, health, mode of living, nutrition, size, skill, temperament, and training; variables of the surroundings, including appliances, clothes, color, entertainment, heating, lighting, quality of material, rewards and penalties, size of unit moved, special fatigue-eliminating devices, surroundings, tools, union rules, and weight of unit moved; variables of the motion, including acceleration, automaticity, combination with other motions, cost, direction, effectiveness, foot-pounds of work accomplished, inertia and momentum overcome, length, necessity, path, play for position, and speed. The application of motion study to operations so small that they cannot be noted by the human eye unaided is accomplished by means of moving pictures.[2]

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[1] Motion Study. New York, 1911. See also ch. xiv of his Bricklaying System. New York, & Chicago, 1909.

[2] " Micro-Motion Study — a New Development in Efficiency," Scientific American, vol. 108, p. 84. An illustration of the kind of results achieved is given by Mr. H. L.

The result of properly directed time and motion study is the standardization of methods and equipment to secure the largest output in the minimum time with no material increase of effort. Once standardization is effected, the method is reduced in detail to writing in the form of an instruction card [1] which is given the operator as a guide to the accomplishment of the predetermined standard of production.

The multiplicity of data from which instruction cards are compiled must be reduced to such form that they can easily be made available. Particularly is this true in the case of the conditions affecting the most economical cutting of metal. The vast body of information on this subject as given in such a work as Mr. Taylor's "Art of Cutting Metals" [2] must, for practical purposes, be made handy for use by the instruction card man. This is the purpose of the slide rules devised and described by Mr. Carl G. Barth.[3] Mr. Barth shows how the same methods by which slide rules for the solution of ordinary mathematical problems have been constructed, may be applied to the construction of slide rules for the solution of the more complicated mathematical problems involved in the determination of the proper speed, feed, and depth of cut for machine tools.

Gantt, "'Hipped' on Motion Study," Industrial Engineering, vol. 8, p. 307, and by Mr. William D. Ennis, "An Experiment in Motion Study," ibid., vol. 9, p. 462. Professor Walter D. Scott, "The Rate of Improvement in Efficiency," System, vol. 20, p. 155, presents a useful side-light on its application. The following articles show how it may be used in fields outside manufacturing: Mr. E. M. Wooley's "Lost Motions in Retail Selling," ibid., vol. 21, pp. 366, 465, "Getting Out the Mail," ibid., p. 284, and Mr. J. G. Frederick and Mr. H. S. McCormack's "Motion Study in Office Work," ibid., p. 563.

[1] These instruction cards are illustrated in the article by Mr. Hathaway on time study referred to above, and in the following: Mr. H. W. Reed's "Following a Fixed Schedule Under the Taylor System," American Machinist, vol. 35, p. 1020; and "Two Turret Lathe Instruction Cards," ibid., vol. 36, p. 915. See also Mr. Frank B. Gilbreth's "The Instruction Card as a Part of the Taylor Plan of Management," Industrial Engineering, vol. 11, p. 380.

[2] Trans. A. S. M. E., vol. 28, p. 31.

[3] "Slide Rules as Part of the Taylor System," Trans. A. S. M. E., vol. 25, p. 49.

In spite of the fact that standardization is so fundamental a feature of scientific management, nothing of any consequence has been written on the subject.[1] In an article by Mr. P. Ballard,[2] the movement is criticized as not scientific, because its standardization methods stand in the way of progress. This illustrates a common fallacy in the discussion of standardization as that term is used by the scientific managers. It must be understood that standardization in their sense does not mean standardization of product, which is the common acceptance of the term, but the determination of the best material, equipment, and process discoverable at any given time and adherence to it until a better is found. So far from standing in the way of progress, this conception of standardization rather stimulates and aids more rapid improvement.

In the Taylor System, the term " routing " has two significations. Sometimes it refers to the physical layout of plants and the relationship of departments, — in this sense it is most completely treated by Mr. Charles Day;[3] more usually, however, it is concerned with the analysis of the sequence of operations on the work and the determination of the place and time for each operation and group of operations. On this latter, the most intricate feature of the system, practically nothing has been published[4] outside of Mr. Taylor's *Shop Management.*

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[1] The best available is in an article by Mr. Charles Day, " Advanced Practice of Economical Metal Cutting," Engineering Magazine, vol. 27, p. 549, and in a book by Mr. C. U. Carpenter, Profit-Making Management, New York, 1908. There is a brief but suggestive article by Mr. E. M. Wooley on " Scientific Management in the Office," System, vol. 20, p. 3, dealing with the standardization of office equipment and supplies, and a characteristic note by Mr. Frank E. Gilbreth on " The First Case of Standardization," Trans., The Efficiency Society, vol. 1, p. 257, taking the shape of a brick as his example.

[2] " Scientific Management and Science," Cassier's Magazine, vol. 41, p. 425

[3] Industrial Plants. New York, 1911.

[4] The only reference of consequence outside the books is the article by Mr. H. L. Gantt, " The Mechanical Engineer and the Textile Industry," Trans. A. S. M. E., vol. 32, p. 499.

Another characteristic feature of the Taylor System is the extensive use of classification and mnemonic symbolization. A series of articles by the present writer, points out the purposes and methods of classification and mnemonic symbolization and its application to the various functions of costs, administration, stores system, routing, and filing.[1]

Altho the Taylor System has a distinctive type of cost accounting, its details have not been published. The first part of Mr. Holden A. Evans' book[2] deals with the subject, but not exactly in the manner in which it is practised by the Taylor group.[3]

The Taylor method of administering a tool room is admirably described by Mr. R. T. Kent,[4] emphasizing the importance of standardization, classification, maintenance, and control. The administration of belting is discussed by Mr. F. W. Taylor.[5]

Attention has often been called to the fact that the second cardinal principle in Mr. Taylor's system, the scientific selection and training of employees, has received no systematic treatment at the hands of the Taylor group, at least so far as selection is concerned. Training is duly emphasized and illustrated by Mr.

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[1] C. B. Thompson, "Giving a Business a Memory," System, vol. 22, p. 588; "Memory Tags for Business Facts," ibid., vol. 23, p. 21; "Taking Factory Costs Apart," ibid., p. 131; "Listing Stock to Index Wastes," ibid., p. 260; "Keeping Tab on Finished Parts," ibid., p. 386; "Right Filing and Easy Finding," ibid., p. 586.

The only other article on the subject is a brief abstract of a paper by Mr. H. G. Benedict, "The Mnemonic Symbolizing of Stores under Scientific Management," Industrial Engineering, vol. 12, pp. 24, 69.

[2] Cost Keeping and Scientific Management. New York, 1911.

[3] Mr. A. Hamilton Church's, The Proper Distribution of Expense Burden, New York, 1908, and Production Factors, New York, 1910, describe a method arrived at by him quite independently, which has been used in part for some time by the Taylor group. There is a brief anonymous article on "Cost and Time Keeping Outfit of the Taylor System," American Machinist, vol. 29, p. 761, and another by Mr. Charles J. Simeon on "The Scientific Management of a Foundry," Iron Trade Review, vol. 50, p. 68, which deal with some of the mechanical details.

[4] "The Tool Room under Scientific Management," Industrial Engineering, vol. 9, p. 87.

[5] "Notes on Belting," Trans. A. S. M. E., vol. 15, p. 204.

Gantt in his *Work, Wages and Profits* referred to above. There are two good popular articles on the subject by Mr. E. M. Wooley, "The One Best Way," and "The Wanton Waste of Labor" referred to above. The only thing I have found on the selection of employees by any one even remotely connected with scientific management is a pamphlet by Mr. Harrington Emerson,[1] and this is an argument for the application of a system of selection which can only be characterized as a refined and slightly modernized phrenology, described in a book by the originators, Dr. Katherine M. H. Blackford and Mr. Arthur Newcomb.[2]

It must be evident from this survey that the literature dealing with the actual method of applying scientific management is as yet quite meagre. This situation is due to a number of factors, one among which is the natural reluctance of specialists to divulge the details of their profession, because of their apparently well-grounded fear that the attempt to describe methods which must be modified to meet a wide variety of contingencies must necessarily be inadequate and to a certain extent misleading, and that therefore it is safer not to attempt at all to describe them in writing. In view, however, of the rapid extension of scientific management to many varieties of industries, and the comparative scarcity of qualified "experts," it appears that the time is ripe for such an exposition of methods as may be immediately and directly useful to any manager of the requisite intelligence to sense their place in the system and to apply them with the thoroness and discretion necessary.

This criticism of meagreness does not apply to one of the principal methods of scientific management, — the use of wages as an incentive. There is nothing new about such use of wages, but the method of the Taylor group is characteristically different. With them wages are not used primarily as an incentive to production but as an incentive to the acceptance of standardized conditions and training and the following of instructions. Increased production is the direct result not of the bonus or differential piece rate systems but of the utilization by the employee, in consideration of higher wages, of the improved methods, materials and equipment provided him by the management. This was the point, tho it is not made very clear, in Mr. Taylor's paper on "A Piece Rate System and Shop Management" referred to above, and it runs all through Mr. Gantt's *Work, Wages and Profits*.[1]

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[1] The Scientific Selection of Employees. The Emerson Company, 30 Church Street, New York.

[2] The Job, the Man, the Boss. New York, 1914.

5. THE PERSONAL FACTOR IN SCIENTIFIC MANAGEMENT

The apparently cold-blooded statements of Mr. Taylor in *Shop Management* and *The Principles of Scientific Management* in regard to his methods of training employees and the mathematical determination of the incentives which actuate their conduct have led to a considerable discussion of the treatment of the " human factor " by scientific management. Discussion is usually based on the truisms that system cannot take the place of honesty and intelligence, that specialization can be carried too far, that driving is an undesirable feature of factory management, that the workmen should not be made into automata, that they should not be set working against each other's interests, that attention should not be centered exclusively upon men above the average of ability, that the factors of habit and prejudice should not be ignored, that no solution of economic problems is complete which ignores the problem of distribution, and that the desires and aspirations of the men toward self-government and democracy must be recognized. Most of these points are mentioned in the Report of the House Committee on Labor appointed to investigate the Taylor and other Systems of Management,[1] leading to the conclusion that no recommendations were necessary, presumably because the criticisms suggested did not apply to the Taylor System.

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[1] This is brought out a little better by Mr. Harrington Emerson in a paper on "A Rational Basis for Wages," Trans. A. S. M. E., vol. 25, p. 868. Out of the mass of books and articles on this subject, the following are also suggested, not necessarily because they are written by members of the Taylor group, which few of them are, but because a study of them will help make clear the philosophy of the use of wage systems by that group. The following are comparative discussions of various methods of wage payment: Mr. S. E. Thompson's "The Taylor Differential Piece Rate System," Engineering Magazine, vol. 20, p. 617; "Differential Piece Rates" (anonymous), Engineering, vol. 80, p. 413; Mr. Clive Hastings' "The Efficiency of the Worker and His Rate of Pay," American Engineer & Railroad Journal, vol. 81, p. 238; Mr. Harrington Emerson's "Different Plans of Paying Employees," Iron Age, vol. 82, p. 1150; and Mr. C. B. Thompson's "The Reason for a Payroll," System, vol. 22, p. 249, and "When Higher Wages Pay," ibid., p. 339. To get one's bearings in the discussion, the articles by Messrs. Towne, Halsey and Rowan referred to above, should be read, and the following: Mr. W. O. Walker's "The Value of Incentives," American Machinist, vol. 26, p. 996; and Mr. C. J. Morrison's "Piece Rates versus Bonus," ibid., vol. 36, p. 178. Highly interesting in this connection are also Mr. Carroll D. Wright's "Profit Sharing,"

The importance of a consideration of the human problem is emphasized by Mr. William C. Redfield.[2] The nature of the psychological problems involved and an indication of the method of approach to their solution are discussed at some length by Professor Hugo Münsterberg.[3] The significance of the work begun by Mr. Taylor and his associates as it appears to a psychologist is emphasized, and examples are given of the more refined methods by which the psychological laboratory

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Bureau of Statistics of Labor, No. 15; and the Report of the British Board of Trade on Profit Sharing and Labour Co-partnership in the United Kingdom. London, 1912.

[1] Government Printing Office, Washington, 1912.

[2] " The Moral Value of Scientific Management," Atlantic Monthly, vol. 110, p. 411.

[3] Psychology and Industrial Efficiency. Boston, 1913.

may be made an aid in the discovery of principles for industrial application.[1]

In a remarkable book by Miss Josephine Goldmark,[2] there is a suggestion that, altho scientific management has thus far avoided the pitfall of driving, there has not been the intensive and scientific study of fatigue which might reasonably be expected from the scientific attitude of the leaders in the movement. Mr. F. H. Dwight [3] insists that the bonus as applied at the Bethlehem Steel Works is but another method of driving. The completest answer to the criticism of practice, no matter what may be said in regard to the absence of a scientific study of fatigue, is made by Clark & Wyatt,[4] who give the results of an intensive investigation of the effect of the Taylor System on women employed under it. This inquiry, begun with the expectation of finding the science of driving reduced to practice, ended after exhaustive personal study in many plants in a complete exoneration of the Taylor-Gantt methods from this charge.[5]

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[1] The fear that scientific management is an effort to substitute a system for integrity and ability is voiced by Mr. F. J. Whiting in " The Personal Equation in Scientific Management," Stone & Webster's Journal, vol. 8, p. 411. The fear of over-specialization finds expression in an editorial in Engineering (London) on " Scientific Management," vol. 93, p. 289, and is apparently the point of an article by Dr. Luther H. Gulick on " The Human Element," Transactions of the Efficiency Society, vol. 1, p. 181, and of one by Mr. A. Hamilton Church on " Intensive Production and the Foreman," American Machinist, vol. 34, p. 830. The answer to these may be deduced from Mr. M. P. Higgins' " Intensified Production and Its Influence Upon the Worker," Engineering Magazine, vol. 20, p. 568; Mr. Frank H. Rose's " The Rise of Labor Through Labor-Saving Machinery," ibid., vol. 27, p. 836; Mr. A. E. Outerbridge, Jr.'s " The Educational Influence of Machinery," ibid., vol. 9, p. 225, and " The Emancipation of Labor by Machinery," ibid., p. 1012. The value of scientific management in finding the place to which the laborer is best fitted and in fitting the man perfectly to fill it is emphasized in an editorial in Machinery, " Helping a Man to Find His Place," vol. 18, p. 279; in Mr. David Van Alstyne's " Profitable Ethics," in " Technology and Industrial Efficiency," p. 207, New York, 1911; and in Mr. Harrington Emerson's " Ethics and Wages," Outlook, vol. 99, p. 682.

[2] Fatigue and Efficiency, The Russell Sage Foundation. New York, 1912.

[3] " The Taylor System as a Machinist Sees It," American Machinist, vol. 34, p. 989.

[4] Making Both Ends Meet. New York, 1911. See especially chap. 8.

[5] Other significant articles on the same subject are: " Scientific Management as viewed from the Workmen's Standpoint," Industrial Engineering, vol. 8, p. 377, and Mr. Wilfred Lewis' " F. W. Taylor and the Steel Mills," American Machinist, vol 34, p. 655.

The criticism that scientific management suppresses the initiative and ambition of the workman is presented by Mr. Frank C. Hudson[1] and further discussed by Mr. Holden A. Evans,[2] and particularly and most effectively by Mr. Charles B. Going[3] who points out that one distinctive feature of the modern systems of management is the restoration of the individuality of the workman.

The complaint that the effect of the task and bonus method is to concentrate the efforts of each workman exclusively upon his own success and well-being, has not been dignified with a formal article, but is given expression occasionally in the hearings before the House Committee on Labor. It is pretty effectively answered in an article by Lieut. E. D. K. Klyce,[4] which points out the absolute necessity of mutual helpfulness and coöperation in the Taylor System.

Mr. Taylor talks so much about the "first class man" and has emphasized so little his explanation that by the first class man he means the man adapted to the job he is doing, that the supposition is only natural that this system aims at the selection of the best only and the elimination of the average and mediocre.[5]

The undue haste with which outside followers of scientific management have attempted to revolutionize the methods and habits of thought of workmen and employers has called forth impressive and valuable warnings from Mr. James Hartness.[6]

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[1] "The Machinist's Side of Taylorism," American Machinist, vol. 34, p. 773.

[2] "Effect of the Taylor System: What is to Become of the Mechanic?" American Machinist, vol. 33, p. 1095.

[3] "The Efficiency of Labor," Review of Reviews, vol. 46, p. 329.

[4] "Scientific Management and the Moral Law," Outlook, vol. 99, p. 659.

[5] Illustrations given by Mr. Taylor do unquestionably show the strongly selective effect of his method; but this should not be allowed to distract attention from the effect of systematic training on the development of average and mediocre into "first class" men. This misunderstanding underlies the criticism in Mr. John R. Godfrey's "Eliminating the Inefficient Man," American Machinist, vol. 34, p. 1232.

[6] "The Factor of Habit," Transactions, The Efficiency Society, vol. 1, p. 237. Still more effective is his book, The Human Factor in Works Management. New York, 1912.

The relation of scientific management to larger social problems is hinted at by Mr. Taylor in *The Principles of Scientific Management* and the ultimate bearing of the application of the system to social welfare, through the reduction of the cost of production and the increase of the purchasing power of the consumer, is briefly suggested. If it could be supposed that the tendencies inherent in the system would be allowed to work themselves out to their logical conclusions, social and economic consequences of a far-reaching nature would reasonably be expected. This possibility has raised unduly the hopes and enthusiasm of some of the advocates of the movement and has brought down upon it the criticism of those calmer individuals who realize, in the first place, that no economic tendency ever does or can work out to its logical conclusion, and, in the second place and particularly, that production and consumption are but a part of the entire economic problem. Those who are looking for a panacea for social ills and who suppose that scientific management was offered as such a panacea are keen to point out that it does not deal finally with the problem of distribution. Professor Edward D. Jones [1] was acute enough to see that Taylor's work developed a principle of distributive justice, namely, the rewarding of the individual for his individual performance, and was not disappointed that it did not go further in this matter than it professed to go. Mr. Dexter S. Kimball in the article mentioned above, Mr. Ralph E. Flanders,[2] and Mr. W. H. Herschel [3] have pointed out, with the air of making a discovery that the

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[1] Review of Taylor's "Shop Management," American Economic Review, vol. 2, p. 369.

[2] "Scientific Management from a Social and Economic Standpoint," Machinery, vol. 18, p. 764.

[3] "Social Philosophy and the Taylor System — Will the Ultimate Result of the Taylor System be Beneficial ?" Engineering News (London), vol. 65, p. 577.

Taylor System does not solve the problem of distribution. Mr. Louis Duchey [1] hails the failure of the system to solve the system of distribution and its one-sided emphasis on production as the force which will do most to intensify class consciousness and hasten the destruction of capitalism.

The test of democracy has of course been applied to this movement. Mr. Meyer Bloomfield [2] points out, apparently with some misgiving, that the loyalty of the employee must be secured by keeping the enterprise democratic; while Mr. Paul U. Kellogg,[3] one of the editors of the *Survey*, is more specific to the effect that this new industrial force must be socialized. Mr. Frank T. Carlton [4] goes still further by pointing out how the movement should be made democratic by giving the workman a voice in the determination of the conditions and the rate of bonus under which he will work. Scant agreement with this conception can be found in the writings of Mr. Taylor. His attitude and that of men of similar training and experience [5] is that the employee has no right to control or participate in the management of the establishment. If this is strictly true, there is obviously in scientific management no place for recognition of trade unionism, the collective bargain, and other mutually agreed arrangements.

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[1] "Scientific Business Management. What is it? What Effect Will it Have on the Revolutionary Movement?" International Socialist Review, vol. 11, p. 628.

[2] "Scientific Management: Coöperative or One-Sided," Survey, vol. 28, p. 312.

[3] "A National Hearing for Scientific Management," Survey, vol. 25, p. 409.

[4] "Scientific Management and the Wage Earner," Journal of Political Economy, vol. 20, p. 834.

[5] "The Human Element in Scientific Management," by Messrs. H. R. Towne, Oberlin Smith, John Calder, A. C. Higgins, and A. Falkenau, Iron Age, vol. 89, p. 912.

6. SCIENTIFIC MANAGEMENT AND ORGANIZED LABOR

The attitude of Mr. Taylor and his immediate followers toward labor organization is difficult to determine from their writings. Thus he says, in *Shop Management:* " There is no reason why labor unions should not be so constituted as to be a great help both to employers and men. Unfortunately, as they now exist they are in many, if not most, cases a hinderance to the prosperity of both." He acknowledges the current obligation of society to organized labor for increased safety, shorter hours and in some cases better working conditions. It appears to be his belief, however, that where scientific management is practised fully and completely, the working man is automatically protected by the self-interest of his employer, owing to the fact that the administration of the task and bonus is dependent on the willing coöperation of the man and the maintenance of his efficiency through the complete standardization of conditions. Nowhere is he very clear, however, on the practicability of the collective bargain in a scientifically managed régime; while on the other hand he is definite and forceful in his denunciation of some of the methods of unionism, particularly the restriction of output.

Whatever Mr. Taylor's real view of the matter may be, the fact is that the labor unions have taken a violent antipathy to scientific management. This is at least partly due to what one writer calls Mr. Taylor's " unfortunate and tactless statements " [1] in regard to labor. There are, however, other and more fundamental reasons for this lack of agreement. An anonymous writer in the *Electrical Railway Journal*[1] points out that specialization, through its easy training of the unskilled, strikes at the heart of labor unionism as at present organized. An editorial in the *World's Work*[2] prophecies that " the foolish unions will oppose it as they opposed the introduction of machinery, and lose." *The Century Magazine*[3] observes that the labor union insists upon "equality." Mr. G. F. Stratton in the *Outlook*[4] finds the point of divergence in the fact that the unions set a minimum wage which the employers treat as a maximum. The chief reason, however, appears to be found in the policy of restriction of output. The belief that restriction of output is a confirmed labor union policy is apparently borne out by the Eleventh Special Report of the United States Commissioner of Labor, on the Regulation and Restriction of Output,[5] — one of those Government reports which, like the report on the hearings before the Labor Committee investigating the Taylor System and the Report of the Civilian Expert Board on Industrial Management of United States Navy Yards, which favored the application of scientific management to the navy yards, was suddenly and mysteriously " out of print " almost immediately after publication.

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[1] Mr. C. H. Stilson, " Letter on Scientific Management," American Machinist, vol. 35, p. 175.

As was seen in an earlier section, railroads in their controversy with the scientific managers have not hesitated to point to the opposition of the labor unions as one of the reasons for the impracticability of the application of the system to their industry, and to substantiate their argument, as in an article in the *Iron Age*[6] by quoting the restrictive laws of such an organization as the International Iron Molders' Union.[1]

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[1] " Scope of Scientific Management," vol. 41, p. 451.

[2] " Scientific Management and the Labor Unions," vol. 22, p. 14311.

[3] " Taking Ambition out of the Workman," vol. 82, p. 462.

[4] " Ca-Canny and Speeding Up," vol. 99, p. 120.

[5] Government Printing Office, Washington, 1904.

[6] " Railroad Efficiency and the Labor Unions," vol. 87, p. 476.

The published expressions of labor union leaders referring directly to scientific management have ranged from an attitude of suspended judgment to one of bitter antipathy. Mr. John Golden of the Textile Workers,[2] is non-committal but suspicious. Mr. J. P. Fry of the Iron Molders [3] is sure that it is at least unscientific. Mr. James Duncan, vice-president of the American Federation of Labor,[4] conveys the impression that scientific management is the summation of all the evils of all the generations of oppression of the working man. Yet this opinion is mild compared with that of the before-mentioned Mr. James O'Connell (now a member of the National Commission on Industrial Relations, which just now is once more investigating scientific management) in an official letter to Machinists' Unions, in which he says: "Wherever this system has been tried it has resulted either in labor trouble and failure to install the system, or it has destroyed the labor organization and reduced the men to virtual slavery, and low wages, and has engendered such an air of suspicion among the men that each man regards every other man as a possible traitor and spy. . . . We trust that you will be impressed with the importance of this matter, and will see the impending danger. Act quickly." The published articles in newspapers on this subject are very numerous; they are not listed here as they are variations on the same theme.

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[1] Other interesting articles on the attitude of the unions towards premium plans are those by Mr. H. M. Norris, " Actual Experience with the Premium Plan," Engineering Magazine, vol. 18, pp. 572, 689, and Mr. James O'Connell, " Piece Work not Necessary for Best Results in the Machine Shop," ibid., vol. 19, p. 373.

[2] " The Attitude of Organized Labor," Journal of Accountancy, vol. 12, p. 189.

[3] " Relation of Scientific Management to Labor," Iron Trade Review, vol. 52, p. 917.

[4] " Efficiency," Journal of Accountancy, vol. 12, p. 26.

The Machinists Union and after it the American Federation of Labor have made the application of scientific management in government arsenals, particularly in the arsenal at Watertown, Massachusetts, the object of their official attack. Reference has already been made to the report of the committee appointed to investigate the trouble there in 1911. In the 1913 report,[1] General Crozier deals with the recent petition of the Watertown employees referred to above. This petition is evidently the first gun in the campaign inaugurated by the American Federation of Labor at their 1913 convention in Seattle, at which they decided officially to fight the extension of the Taylor System.[2]

The best articles counselling the unions to take a saner point of view are those by Mr. Louis D. Brandeis,[3] in which he argues that scientific management is but the application of thought and knowledge to industry, that increased efficiency and production operate in the interest of the working man, and that its progress and ultimate success are inevitable. The same thought is expressed by Mr. Harrington Emerson.[4]

On the other hand, scientific managers have been freely advised to recognize more fully the necessity of coöperation with the unions. This is the attitude of Mr. John R. Commons,[5] who points out that the bonus system implies an individual bargain with the workman, and therefore strikes at the very existence of the union, unless its terms can be made the subject of a collective bargain; of Dr. John H. Gray,[1] and of the present writer,[2] who holds that the labor unions may and should assist in the determination of the standardized conditions and of a day's work and its attainment, and that the existence of the unions is and will continue to be necessary to maintain an adequate minimum wage.

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[1] Report of the Chief of Ordnance, 1913. Washington.

[2] Interesting articles bearing on the subject are those by Mr. Max H. C. Brombacher, "The Rock Island Arsenal Labor Trouble," Iron Age, vol. 89, p. 476; by Lieut.-Colonel W. S. Peirce on "Government Shop Management," ibid., p. 476; and an article, "Scientific Management at United States Arsenals," ibid., vol. 88, p. 1022, which includes a statement of former Secretary of War, Stimson.

[3] "The New Conception of Industrial Efficiency," Journal of Accountancy, vol. 12, p. 35, and "Organized Labor and Efficiency," Survey, vol. 26, p. 148.

[4] "The Fundamental Truth of Scientific Management," Journal of Accountancy, vol. 12, p. 17.

[5] "Organized Labor's Attitude Towards Industrial Efficiency," American Economic Review, vol. 1, p. 463.

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[1] " How Efficiency Should Benefit the Employer, the Employee, and the Public," Transactions, The Efficiency Society, vol. 1, p. 67.

[2] C. B. Thompson " The Relation of Scientific Management to the Wage Problem," Journal of Political Economy, vol. 21, p. 630.